Paper unquestionably is a leading contributor to the advancement of civilization through its use for the inscription, transmission, and recording of thought, and it is difficult to conceive of the modern world without it. So essential is paper in our daily life that it may be said that we could not maintain our civilization at its present level without wood pulp, which constitutes the principal fibrous raw material from which paper is made.

Ancient civilizations carved their laws and history in stone and imprinted them upon bricks. Lead, copper, and brass successively carried the written word. Less permanent materials, such as leaves, bark, wood, and skins, were also employed. Papyrus, from which the name of paper is derived, however, was the nearest approach the ancients made to paper as we know it.

Reaumur, an eighteenth century French physicist, after examining the fibrous nest made by wasps from finely chewed wood, suggested that paper might possibly be made from wood. In 1750 paper was made from the bark, leaves, and wood of various trees in France. The paper machine was invented about 1800 by Louis Robert and was improved later in England by the Fourdrinier brothers for volume production. During the nineteenth century much progress was made in the production of wood pulp for paper, which previously had been made almost entirely from cotton and linen rags.

Pulpwood made its first appearance in the United States in 1869. but, according to census reports, contributed only 2,000 cords to the raw materials used that year in the manufacture of paper. Before the end of the next 20 years, however, the great growth of the American paper-making industry was in full swing.

From the standpoint of value of products, the paper industry in 1939 ranked sixth among the prime manufacturing industries, with a total of over 2 billion dollars, according to Bureau of the Census data. In the same group of industries it ranked fifth in 1940, and in that year employed more than 328,000 people. More than nine-tenths of today's paper comes from wood pulp. The Sunday issue of a large metropolitan newspaper alone consumes all the pulpwood from 75 acres of average forest Paper, as an indispensable commodity of modern life, has emphasized anew our dependence on our forests.

Do you know the origin of the paper from which you are reading? The Government received the paper from the paper mill; the paper mill received its fiber from the pulp mill; and the pulp mill obtained the wood from the forest.

(over)

PULPING PROCESSES

Wood is reduced to a fibrous form suitable for paper making by chemical and mechanical pulping processes or a combination of the two. In the mechanical, or groundwood process, fibers are produced by pressing bolts of wood against the rough surface of a rotating grindstone made of sandstone or synthetic abrasive material. A shower of water is provided to cool the stone and convey the pulp away.

Wood consists primarily of cellulose and lignin, the former constituting about 60 percent and the latter about 30 percent of its weight. In the chemical pulping processes, the natural botanical fibers are separated by dissolving the lignin and other cementing material from wood chips. Solution of the lignin cementing material is accomplished by heating the chips and cooking liquor at high temperatures and pressures in large pressure vessels called digesters The three chemical processes commonly used for pulping are the sulfate or kraft, the soda, and the sulfite. The sulfate and soda processes employ alkaline liquors and the sulfite process an acid liquor.

The processes employing both chemical and mechanical action, often called the semichemical processes, are used much less extensively than the others. In these processes, the chips are first given a mild softening treatment with a chemical cooking liquor, after which they are reduced to fibrous pulp by mechanical treatment in an attrition mill or by similar means.

AMERICAN WOODS FOR PAPER MAKING

In 1944 spruce, hemlock, and pine furnished approximately 83 percent of all the wood used for paper making; about 18 other species of softwoods and hardwoods made up the remainder. Experiments at the U. S. Forest Products Laboratory indicate that, with slight modifications in the standard pulping processes, many other species can be used.

Softwoods or Conifers

SPRUCES - All spruces are suitable for pulping by any of the processes, and all make high-quality pulp except Sitka spruce, which yields a rather coarse-fibered pulp.

HEMLOCKS - Western hemlock is similar to the spruces in pulping quality, although in the groundwood process it requires more power than does spruce to produce pulp of equal quality. Eastern hemlock is not so suitable for groundwood. Chemical pulps made from it are darker, hence require more bleach to lighten their color, and are weaker than spruce pulps.

PINES - All pines are reduced readily in the alkaline processes. The pulps can be bleached satisfactorily under proper conditions. The young, fast-growth Southern yellow pines and lodgepole, ponderosa, sugar, limber, Easternwhite, and jack pine are all suitable for groundwood pulps. The groundwood pulps obtained from all pines cause more or less trouble in paper making because of their pitch content, which limits the proportion in which some of them can be used. For making light-colored unbleached groundwood

pulp, the pine used must be relatively free of heartwood. Young shortleaf, longleaf, loblolly, slash, jack, lodgepole, red, pine, sand, and Virginia pines can be made into fair pulps with a reasonable bleach consumption by slight modifications of the standard sulfite process; with other pines, uniformity of digestion is a problem because of the presence of heartwood which is difficult to digest.

FIRS - All true firs are as readily pulped by any process as is spruce and, with the exception of red fir, are comparable with spruce in quality. Red fir gives a rather dark mechanical pulp, and the sulfite and sulfate pulps made from it are more difficult to bleach than those of spruce.

BALDCYPRESS, DOUGLAS-FIR, LARCHES, REDCEDAR - These are not suitable for the generally acceptable grades of groundwood pulp. Douglas-fir, after a pretreatment with steam or hot dilute alkali, can be ground for pulp suitable for container boards. These woods are digested with difficulty by the sulfite process, but with modifications the process may be used to make commerical pulps. All may be pulped satisfactorily by alkaline processes. The strength characteristics of the pulps vary considerable with the species. Douglas-fir pulps excel in certain properties, while Western redcedar pulps are superior in others. The yield of pulp from redcedar is relatively low.

WHITE CEDARS - The white cedars are readily converted by all processes to fairly acceptable pulps. In comparison with other woods, white-cedars give normal pulp yields on a weight basis, but they give lower yields on a cord basis because the wood is somewhat less dense.

Hardwoods or Broadleaved Species

POPLARS - A number of hardwood species are classified as "poplars" by the pulp industry because of their similar pulping characteristics, although some are botanically dissimilar. As a group, these species constitute the largest quantity of hardwoods used for pulp and paper manufacture. Included in the group are such true poplars as aspen, cottonwood, and balsam poplar, and also yellow-poplar, which botanically is not a true poplar. All can be pulped by the chemical processes to yield short-fibered pulps low in strength, or by the groundwood process. The bleached chemical pulps are used in the higher grades of printing papers. The unbleached pulps are useful in the cheaper printing and wrapping papers. The pulps produced by the groundwood process are used in book papers, tissues, and heavy structural boards, such as insulation. Experiments have demonstrated that appreciable proportions of neutral sulfite semichemical and groundwood pulps made from true poplars may be utilized in the manufacture of newsprint and other printing grades.

BEECH, BIRCH, MAPLE, SWEETGUM, and TUPELO - This group, including the several varieties of the species, constitutes the second largest quantity-group of hardwoods used for pulp. Like the "poplars", they can be pulped by the chemical processes and yield pulps somewhat similar in quality, their use being limited by their low strength. The groundwood pulps, though short-fibered and low in strength, may be blended with other pulps. Recent ex-

perimental work shows that most of the woods are adapted to the manufacture of newsprint, book, toweling, and specialty papers.

OTHER HARDWOODS - Miscellaneous hardwoods used for paper making include principally ash, chestnut (after tannin extraction), elm, oak, willow, and such less-used species as alder, basswood, buckeye, butternut, catalpa, sugarberry, magnolia, mangrove, hickory, locust, sassafras, and sycamore. All may be pulped by the soda and sulfate processes, most of them quite readily. The sulfite and neutral sulfite semichemical processes are also adapted to most of these woods. The lighter-colored species are, in general, suitable for groundwood pulps. Their principal use is in book, magazine, and cheap printing papers, and in corrugated board for shipping boxes.

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United States Forest Service
Washington, D. C.
1946

TO KEEP THE TREES GROWING

Here in the United States we are cutting trees faster than new ones are growing for the future. And because science is showing us how to use wood better and in new ways we are likely to want more trees in the future than we use today. In fact we must double the annual growth of usable wood. This can't be done easily or quickly. It will require decades of good forestry. So we must take steps now—

To protect all our forests well from fire, insects, and disease;

To stop wasteful and destructive cutting;

To keep plenty of trees of all sizes growing to replace those we cut;

To restore commercial tree growth on millions of acres of forests that have been badly treated or burned;

To give farmers and other small owners more help in growing, harvesting and marketing their tree crops;

To put wild land into public forests when private owners cannot take care of it or the public interest calls for special treatment.